ASSESSING USER SATISFACTION OF AIRPORT BAGGAGE HANDLING SYSTEMS

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ABSTRACT

The phrase customer satisfaction is being used more frequently as an indication of the successful operation of a business. However, from background research, it was determined that the design and operational standards for baggage handling systems (BHS) do not consider the level of service (LOS) as perceived by the passengers. Arrival BHS have traditionally been evaluated using time and space standards, but little research has been conducted to correlate these time and space standards with the LOS perceived by the passengers. Moreover, it is evident that a national strategy for defining the user-perceived LOS of BHS and the means to improve this LOS are lacking. A LOS model that can ascertain the user-perceived LOS (UPLOS) being achieved by the BHS would be beneficial to airlines, passengers, and airport designers. The development of such a model would enable airport authorities and airlines to determine when improvements are required and to develop a strategy for implementing the needed changes. This paper presents a study performed at six Canadian airports, where over 800 passengers rated the LOS provided by the overall arrival BHS and its different components. Linear regression analysis was used to relate the UPLOS with various aspects of the BHS, including baggage delivery times, expected and actual waiting times, reclaim area space, and perception of the comfort and safety provided in the reclaim area. The results confirm that traditional time and space standards; currently used by aviation agencies, airports, airlines, and baggage handlers; are not adequate indicators of the UPLOS. Subsequently, aggregate and disaggregate (by annual number of passengers) UPLOS models were developed and should be useful in evaluating BHS nationwide. Regression results indicated that the passenger's perception of comfort and safety in the reclaim area, along with their perception of waiting time, greatly influenced their overall UPLOS evaluation. The paper should be of interest to transportation engineers, airport planners, airlines and the traveling public.

INTRODUCTION

Worldwide air travel is experiencing a continual increase in the demand volume. The total number of passengers carried on worldwide scheduled air services exceeded 1.25 billion in 1995 (*1*) and exceeded 1.5 billion in 1999 (*2*). The Canadian air transportation system must be able to accommodate the ever-increasing number of passengers and their personal needs within the airport system. Not only must airports be able to accommodate the increased volume, but they must do so while maintaining a reasonable level of service and optimizing customer satisfaction.

Surveys have indicated that passengers consider baggage handling to be a very significant issue, placing it near or at the top of their list of air travel priorities (*3*). A delay in the baggage handling system (BHS) can adversely affect the whole operation of the airport facility. In addition, the processing of baggage is a very expensive item for air carriers because of the system wide repercussion of delays and because of the possibility of damaged, lost and stolen baggage, which can add up to a considerable cost to the airline. With the current trend of increasing air traffic, these cost figures are also expected to increase.

Differences have been observed between airlines and airports in terms of their physical ground handling systems, their standards for measuring lost baggage, and their levels of service. While all parties share the objective of improving the BHS through reducing the amount of mishandled baggage, increasing the LOS provided to the passengers, increasing the operating capacity, and improving safety and security, established methods for evaluating these improvements are not available. In particular, there is no established method for determining the LOS of BHS as perceived by the passenger.

This paper presents disaggregate user-perceived LOS (UPLOS) models that complement the aggregate LOS models presented by Pagani et al *(4)*. The models are developed based on the results of a survey on a passenger's evaluation of BHS at six Canadian airports. The disaggregate LOS models consider the commonly used variables of space requirements and service times in addition to emphasizing user preference and perception variables. The introductory sections in Pagani et al *(4)* are repeated here as they represent useful background information. It should be mentioned that this paper focuses on evaluating the LOS of arrival baggage only. The following sections present an overview of the current status of the evaluation methods of baggage handling systems and a summary of the responses and standards. Regression analysis is then used to develop UPLOS models (aggregate and disaggregate) that identify the effect of each variable on the LOS perceived by the airport user. A detailed discussion of the UPLOS models is then presented, followed by the concluding remarks.

OVERVIEW

From background research, it is evident that a national strategy for defining the LOS of BHS and the means to improve this LOS are lacking. Moreover, as the demand for air transportation is growing, all airports and airlines will reach capacity and realize their inability to handle the significant increase in the amount of baggage to be processed. In addition, larger aircraft with greater seating capacities are currently being developed (*5*) and will strain the BHS even further.

Without improving the capacity of the airport terminal facilities to match this increase in the amount of baggage, the overall quality of service offered by Canadian airports is likely to deteriorate. Clearly, a LOS model that can ascertain the LOS being perceived by the users would be beneficial to airlines, passengers and airport designers. The development of such a model would enable airport authorities and airlines to determine when improvements are required and to develop a strategy for implementing the needed changes.

The state of LOS evaluation in airport terminals is much less advanced than that of highway analysis. Methods used for terminal evaluation have evolved in the past, but a single universal method has not been developed (*6*). The approach used by many agencies, including the British Airport Authority (BAA), the International Air Transport Association (IATA), and Aeroports de Paris has been to set time and space standards separately. However, these design standards did not take into account the passenger's perception.

Similar to the evaluation of highway LOS, Transport Canada (TC) proposed a method that sets different levels of space provisions for the six different levels of service from A to F (*7*). The space provisions proposed by TC, in addition to the more stringent standards suggested by IATA, are shown in Table I (*8*). The linearity of the relationship between space provisions and LOS suggests a lack of a relationship between these space provisions and the LOS perceived by users (*6*).

A preliminary assessment of BHS in Canadian airports was carried out in this study to identify existing deficiencies. A shared deficiency of the BHS was found to be the lack of a common method for measuring the LOS perceived by the passengers. Furthermore, there are no Canada wide or worldwide standards explicitly identifying the quality of service that should be provided based on time, space, and other factors affecting a passenger's perception. Due to these obvious needs in the Canadian baggage handling system, research in this area is required. The need for developing a model that can determine the LOS provided by the BHS and perceived by airport users is evident. Such a LOS model would allow airports and airlines to analyze their BHS and determine the LOS perceived by the passengers. A LOS model could also lead to the identification of appropriate strategies for airport improvements based on the factors that affect the LOS of BHS. The models, evaluated using a comprehensive survey of Canadian airports, can determine the UPLOS.

Table I.

Air Terminal Building Space Standards.

Facility	Minimum LOS Space Provisions (m^2/occupant)					
	A	B	C	D	E	F
Transport Canada - Bag Claim Area (without device) (*7*)	> 1.6	1.4	1.2	1.0	0.8	< 0.8
International Air Transport Association – Bag Claim Area (without device) (*8*)	> 2.0	1.8	1.6	1.4	1.2	< 1.2

Source: Pagani et al, 2002.

SUMMARY OF RESPONSES AND STANDARDS

Studied Airports

The information required concerning BHS was collected from six Canadian airports. A three-part questionnaire was developed to address the level of service perceived by the passengers. Data collected from the questionnaire included flight details, personal information (i.e. gender, age range, trip purpose) and the passenger's perception of various aspects of the BHS. Response rates from the six airports varied from 90% to 97%.

The six Canadian airports ranged in size from small to large. In terms of their annual passenger traffic levels, the airport with less than 1 million annual passengers was considered a small airport, while four airports with between 1 and 10 million annual passengers were considered to be medium airports. With more than 10 million passengers, one airport was considered to be large. In order to keep the airport names confidential, the airports are referred to by size, as SMALL, MEDIUM1, MEDIUM2, MEDIUM3, MEDIUM4, and LARGE. For the purpose of this research paper, general LOS models are is being developed and thus the names of the airports where data were collected are not of concern.

Among the six airports, manual and semi-automatic sorting methods were observed. In addition, airports with either centralized or decentralized sorting areas were included in the research. Also, minimums of three reclaim conveyor belts were in operation at each of the six airports. Therefore, the airports evaluated in this study varied in locale, size, and baggage handling system characteristics. This data, along with information collected from the passengers were used to develop the UPLOS model presented in this paper.

Evaluation of Time and Space Standards

Time Standards

As mentioned earlier, organizations such as the BAA, IATA, and Aeroports de Paris suggest design space and time standards for the baggage reclaim area. These organizations set limits for the passenger's waiting time to create standards for the service being provided. The BAA, IATA and Aeroports de Paris use a design standard of a maximum of 25 minutes between the arrival of the first passenger and the arrival of the last bag on the conveyor. IATA also stipulates that 90% of the passengers should wait less than 20 minutes for baggage.

The results indicated that three of the six airports investigated failed the former standard at least once. The corresponding failure rates for this standard were 6.7% (1 of 15 flights) at MEDIUM3, 20% (1 of 5 flights) at MEDIUM4, and 33% (4 of 12 flights) at MEDIUM1. It should also be noted that some flights at MEDIUM4 and LARGE would have failed this standard more often had it been possible to record the time of the last bag for all flights. However, the time that the last bag arrived on the conveyor belt could not be recorded when more than one flight used the same conveyor belt simultaneously.

As for the latter time standard, only the smallest airport met this standard for all of the 12 observed flights. The percentage of flights at the five other airports that failed this IATA standard ranged from 10% (MEDIUM3) to 25% (MEDIUM4). Thus, only the smallest airport satisfied both of these time standards for all flights observed.

Space Standards

Two variables commonly used for space standards include square meters per passenger and conveyor belt frontage per passenger (*6*). The Aeroports de Paris (ADP) considers that a reclaim frontage of 1.0 m for every 5 passengers is a reasonable standard. The design space standards used by the BAA state that 1.25 m^2 be provided in the reclaim area per domestic passenger, 2.0 m^2 per short haul international passenger, and 3.25 m^2 per long haul passenger. The IATA design standards state that 0.8 m^2 be provided in the reclaim area per domestic and short haul international passenger, and that 1.6 m^2 be provided per long haul passenger. Referring to Table I, these latter standards correspond to a LOS of C. The operational space standards used by TC to determine which LOS is being provided are also listed in Table I.

The research indicated that all flights except one of 19 observed flights at MEDIUM3, met (or improved on) the ADP standard. With reference to the BAA and IATA design standards, it was found that all flights at SMALL and MEDIUM2 met the standards used by both the IATA and the BAA. On the other hand, 31% of domestic flights (4 of 13) at MEDIUM1, 75% of international long haul flights (3 of 4) at MEDIUM4, 7.7% of domestic flights (1 of 13) and 20% of short haul international (1 in 5) at MEDIUM3, and 14% of short haul international flights (1 of 7) and 100% of long haul international flights (3 of 3) at LARGE did not meet (failed) the BAA standards. Additionally, 67% of long haul international flights (2 of 3) at LARGE did not meet the less stringent IATA design standards.

With reference to the TC operational standards for the LOS provided in the baggage reclaim area, SMALL, MEDIUM2 and MEDIUM4 provided a LOS A for all observed flights. A LOS A was provided by 61.5% of flights (8 of 13) at MEDIUM1, 89.5% (17 of 19) at MEDIUM3, and 90.5% (19 of 21) at LARGE. Thus, with the exception of MEDIUM1, a LOS A was provided for more than 89% of the flights at each airport. Furthermore, a LOS A was provided for all observed flights at three of the airports. However, these standards indicate the LOS being provided by the airport baggage handling system rather than the LOS being perceived by the passengers.

According to the above time and space standards, a high percentage of the total flights provided a reasonable LOS. However, from the passenger responses, obtained through the use of the questionnaire, the percentage of people satisfied with the service was *less* than the percentage of flights providing a reasonable LOS. Thus, the standards used by these agencies failed to reflect the LOS *perceived* by the passengers interviewed in this study.

REGRESSION ANALYSIS

The data were initially screened, following which regression analyses were carried out to develop an aggregate model that considered all airports simultaneously and a disaggregate model that considered airports by annual passenger volumes. All statistical analysis discussed in this section was carried out using SPSS software. Note that a complete description of the variables used in this paper is available in Table II.

Regression Using Traditional Space and Time Variables

As discussed in previous sections, the LOS of BHS has traditionally been determined through the use of the three time and space standards measured in the reclaim area: the passenger's waiting time (TIMEWAIT), the area per passenger (M2PERPAS), and the number of passengers per metre length of conveyor (PASPERM). Using linear aggregate regression analysis, these three independent variables were used to describe their relationship with the dependent variable, UPLOS.

By forcing all three variables into the regression model, an R^2 of only 0.211 was achieved. However, in testing the significance of the coefficient for M2PERPAS (null hypothesis, H_0: coefficient is equal to zero), the P-value was 0.335, and thus H_0 should be rejected at 0.05 level of significance. A *stepwise* regression resulted in two significant independent variables, TIMEWAIT and PASPERM, with a resulting decrease in the R^2 value. Since the traditional method has been to use these three variables as an indication of LOS, the low R^2 value of 0.211 indicates that these three variables together only account for 21.1% of the variation in the dependent variable, UPLOS. Thus, as hypothesized in this paper, these three variables alone are inadequate for determining the UPLOS.

Aggregate Regression with User Perception Variables

A linear aggregate regression analysis was conducted by including all collected variables and using the stepwise method for entering the variables. Thus, variables were entered into the model if the probability of F was less or equal to 0.05, and variables were removed from the model if the probability of F was more or equal to 0.10. The resulting aggregate model was as follows.

$$\begin{aligned} UPLOS &= 0.362 + 0.391\,(WAITTIME\!:\ R) + 0.330\,(COMFSAFT\!:\ R) \\ &\quad + 0.126\,(WALKTIME\!:\ R) + 0.802\,(GETBAG\ \ 01) \end{aligned}$$

Table II

Summary of Variable Names and Descriptions.

Variable Name	Variable Description
BUSYPASS	Maximum number of people in the reclaim area waiting for baggage
CHEKBAGS	Number of bags checked by the passenger
CHFLIGHT	Type of flight (domestic, international)
COMFSAFT:R	Level of personal comfort and safety perceived in the reclaim area
DISTGATE	Distance in metres between the arrival gate and the reclaim area
EDGSPACE:R	Space provided along the conveyor belt for baggage collection
EXPEDLAY	Difference between the expected and perceived waiting times. Positive value indicates that expected waiting time is greater than perceived waiting time
FLIGHTYR	Number of flights taken by the passenger per year
GENDER01	Passenger's gender (GENDER01 = 0 for male respondents and 1 for female)
GETBAG01	Whether baggage was received (GETBAG01=0 if bag received, otherwise=1)
M2PERPAS	Area (m^2) per passenger in the reclaim area measured at the busiest time
OVRSPACE:R	Overall space in the reclaim area
PASPERM	Number of passengers per metre length of conveyor at the busiest time
PXBGDLAY	Time difference between arrival of first passenger and first item of baggage
RENO01CO	Whether a renovation had been completed in the past decade
SEATING:R	Amount of seating provided in the reclaim area
SEATS#	Number of seats in the reclaim area
TIMEARR	Perceived walking time between the arrival gate and the reclaim area
TIMEGATE	Author's measured walking time between the arrival gate and the reclaim area
TIMEWAIT	Passenger's waiting time in the reclaim area
WAITTIME:R	Time spent waiting to collect baggage in the reclaim area
WALKDIST:R	Walking *distance* between the arrival gate and reclaim area
WALKTIME:R	Walking *time* required to travel from the arrival gate to reclaim area

Source: Pagani et al, 2002.

a. Note that the ':R' included in the variable name indicates that the variable is a rating.

As presented by Pagani et al *(4)*, the final model, above, included four variables, was significant at 0.0005, and had an R^2 of 0.636. The significant variables were: the passenger's rating of waiting time (WAITTIME:R), the rating of comfort and safety (COMFSAFT:R), the rating of walking time between the arrival gate and the reclaim area (WALKTIME:R), and whether the bag was received (GETBAG01 = 0 if bag was received and 1 otherwise).

Disaggregate Regression with User Perception Variables

Subsequently, the six airports were separated into categories based on their annual passenger volume. Regression analysis was carried out to determine the significant variables that influenced a passenger's perception of the BHS for three different airport sizes. Linear regression models were developed using the stepwise method of entering variables into the model. The linear regression equations developed for these three airport sizes were as follows.

- Small Airports (< 1 million annual passengers): P-value = 0.0005, R^2 = 0.550.

$$UPLOS = 0.802 + 0.387(WAITTIME:R) + 0.232(COMFSAFT:R) + 2.579(GETBAG01)$$

- Medium Airports (1-10 million annual passengers): P-value = 0.014, R^2 = 0.589.

$$UPLOS = 0.613 + 0.334(WAITTIME:R) + 0.307(COMFSAFT:R) \\ - 0.0196(EXPEDLAY) + 0.123(WALKTIME:R) + 0.538(GETBAG01)$$

- Large Airports (> 10 million annual passengers): P-value = 0.049, R^2 = 0.618.

$$UPLOS = 0.365 + 0.342(OVRSPACE:R) + 0.298(WAITTIME:R) \\ + 0.223(WALKTIME:R)$$

In addition to the four significant variables included in the aggregate UPLOS model, EXPEDLAY and OVRSPACE:R were found to be significant. EXPEDLAY measured the difference between the expected and perceived waiting times. Thus, a positive value for EXPEDLAY indicated that the expected waiting time was greater than the perceived waiting time. OVRSPACE:R was the user's rating of overall space in the reclaim area.

DISCUSSION

Aggregate Model

The aggregate model indicates that as the passenger's ratings for waiting time, and comfort and safety in the reclaim area, and the rating for walking time from the arrival gate worsen, the overall UPLOS worsens. Additionally, the UPLOS worsens if the bag is not received. Since these variables are also included in the disaggregate regression models, a discussion of these variables can be found in the next section.

When comparing the coefficients for WAITTIME:R and WALKTIME:R, one might reach the erroneous conclusion that longer walking times as opposed to longer waiting times result in a better UPLOS. This research does not validate this suggestion and instead found that passengers regard time, whether spent walking or waiting, in the same manner *(4)*.

The four-variable linear aggregate regression model, presented by Pagani et al *(4)*, with an R^2 value of 0.636, represents a significant improvement of more than 300% over the traditional time and space standards (R^2 = 0.211). Although at first glance, an R^2 of 0.636 might not appear to be very high for engineering applications, one must consider that both quantitative and subjective variables are involved in this passenger perception model. Other regression analyses conducted in the social sciences have produced significant models with R^2 values significantly less than 0.636. People and their perceptions are very unpredictable variables to control and model.

Disaggregate Model

As with the aggregate model, the three linear disaggregate regression models improved upon the traditional LOS evaluation methods by 260%, 279%, and 293% for the small, medium, and large disaggregate regression models, respectively. The significant independent variables from the disaggregate regression analyses can predict the user-perceived LOS of the BHS better than the traditional variables. Table III provides a summary of the independent variables.

Table III

Summary of Independent Variables for Disaggregate Regression Models

Independent Variable	Variables that Predict these Independent Variables
a) Small Airports	
Rating for Waiting Time	Perceived waiting time
Rating for Comfort and Safety	Perceived waiting time, Whether renovation recently undertaken in reclaim area, Number of seats in the reclaim area, Type of flight, Maximum number of people in reclaim area, Number of checked bags per passenger
Whether Bag was Received	
b) Medium Airports	
Rating for Waiting Time	Perceived waiting time, Difference between expected and perceived waiting time, gender, Time between arrival of first passenger and first bag in reclaim area, Whether bag was received, Number of flights taken by passenger per year
Rating for Comfort and Safety	Perceived waiting time, Whether renovation recently undertaken in reclaim area, Number of seats in the reclaim area, Type of flight, Maximum number of people in reclaim area, Number of checked bags per passenger
Difference between Expected and Perceived Waiting Time	
Rating for Walking Time	Distance between arrival gate and reclaim area, Passenger's perceived time to walk from arrival gate to reclaim area
Whether Bag was Received	
c) Large Airports	
Rating for Overall Space	Maximum number of passengers in reclaim area, Whether renovation recently undertaken in reclaim area, Number of flights taken by passenger per year, Number of checked bags per passenger, Total length along conveyor belt
Rating for Waiting Time	Difference between expected and perceived waiting time, perceived waiting time, Number of flights taken by passenger per year
Rating for Walking Time	Distance between arrival gate and reclaim area, Passenger's perceived time to walk from arrival gate to reclaim area

Rating of Waiting Time in Reclaim Area

Regardless of the airport size, the *rating* of the waiting time on a scale of excellent (value =1) to unacceptable (value = 6), as opposed to the perceived waiting time in minutes, was one of the independent variable to be included directly in the regression model. The positive relationship indicated that as the rating of waiting time worsened (increased in value), the UPLOS worsened.

While the perceived waiting time (TIMEWAIT) is not directly in the passenger perception regression equations, it has a significant relationship with, and is accounted for by, the WAITTIME:R variable in the new model. WAITTIME:R also had a significant relationship with five other independent variables: difference between passenger's expected and perceived waiting times (EXPEDLAY), passenger's gender (GENDER01), time difference between arrival of the first passenger and the first item of baggage (PXBGDLAY), whether the bag was received (GETBAG01), and number of flights taken by the passenger per year (FLIGHTYR).

The relationship was positive for the variables TIMEWAIT, PXBGDLAY, GETBAG01 and FLIGHTYR. As the perceived waiting time increases, the rating worsens, or increases in value from 1 (excellent) to 6 (unacceptable). PXBGDLAY was calculated by subtracting the arrival time of the first item of baggage from the arrival time of the first passenger; thus, a positive value indicates that the first passenger arrived before the first item of baggage. As PXBGDLAY increases, WAITTIME:R worsens, or increases in value from 1 to 6. The variable GETBAG01 was given a value of one (1) if the bag was not received and thus, the rating worsened. As the number of flights taken annually (FLIGHTYR) increases, the rating worsens indicating that frequent flyers were less tolerant than people who travel infrequently.

A negative relationship was evident between WAITTIME:R and EXPEDLAY and GENDER01. EXPEDLAY was calculated by subtracting the perceived waiting time from the expected waiting time. Thus, a positive value for EXPEDLAY indicated that the expected waiting time exceeded the perceived waiting time, and the respondent's expectations were met. A positive value resulted in an improvement in the rating for waiting time, or a decrease in the value of the rating. The variable GENDER01 received a value of 0 for male respondents and a value of 1 for female respondents. Thus, holding other independent variables constant, female respondents tended to rate the waiting time better than male respondents did.

Rating of Comfort and Safety in Reclaim Area

At small and medium airports, the COMFSAFT:R variable heavily influenced the UPLOS. Thus, by improving the level of comfort and safety, the UPLOS improved. Although the COMFSAFT:R variable has a qualitative rating value, it is affected by quantitative measures.

From analysis of the rating for comfort and safety (COMFSAFT:R) and through the use of scatter plots, it was determined that comfort and safety should have been considered as separate questionnaire items. Some passengers indicated a response for their perception of safety, while others provided a response for their perception of comfort. Although the respondent's perception of safety could lead to a sense of comfort, other aspects of the BHS and reclaim area influenced a respondent's perception of comfort. However, a significant relationship was found between COMFSAFT:R and six variables: perceived waiting time in the reclaim area (TIMEWAIT), whether a renovation had been completed in the past decade (RENO01CO, i.e. airport operating under capacity and modern waiting areas), number of seats in the reclaim area (SEATS#), type of flight (CHFLIGHT), maximum number of people in the reclaim area waiting for baggage (BUSYPASS), and number of bags checked by the passenger (CHEKBAGS).

Unlike the small and medium airport models, the large airport regression model included OVRSPACE:R, but not COMFSAFT:R. A strong correlation was found between these two variables. Additionally, LARGE provided the lowest average value of space per passenger in the reclaim area. Having 7.1 m^2 per passenger, on average, the UPLOS at the large airport was influenced by OVRSPACE more than COMFSAFT:R.

Rating of Walking Time between the Arrival Gate and Reclaim Area

The relationship between WALKTIME:R and UPLOS at both medium and large airports indicates that passengers perceive the space from the arrival gate to the reclaim area as part of the BHS and thus, LOS evaluation techniques should include some measure of this aspect.

Whereas at the small airport, the average perceived walking time was only 2.9 minutes, the perceived walking time at the medium and large airports was from 4.7 minutes (62% greater) at MEDIUM1 to 7.5 minutes (159% greater) at MEDIUM4. Thus, an average walking time of 2.9 minutes was perceived by the passengers as reasonable and did not influence the UPLOS, whereas an average walking time of 4.7 minutes or greater did influence the UPLOS.

The WALKTIME:R variable has qualitative rating values, however, it is affected by quantitative measures. Regression analysis indicated that a significant relationship existed between the WALKTIME:R variable and two independent variables: the distance in metres (DISTGATE) and the perceived walking time between the arrival gate and the reclaim area (TIMEARR). As both these independent variables increase in value, the UPLOS worsens.

Whether Baggage was Received from Reclaim Conveyor Belt

Referring to the disaggregate regression equations, GETBAG01, the variable identifying whether the baggage was retrieved from the conveyor belt or not, was found to be a significant variable at both small and medium airports. As expected, a value of one for the variable GETBAG01 (baggage not retrieved) worsened the rating for UPLOS. The difference in the value of the coefficient for GETBAG01 between small and medium airports is worth noting. At small airports, if the baggage was not received, the rating for UPLOS increased by 2.54 units, on a scale of only six increments. Thus, the expectation at small airports was that the baggage should arrive safety, due to the small size of the airport. Alternately, at medium airports, the rating worsened by only 0.729 for those respondents that did not received their baggage. Passengers realized that the chance of their baggage not arriving was greater at the medium airports than at the small airports and thus, placed less importance on that aspect of the BHS. In addition, since more flights arrive and depart from medium airports, a delayed item travelling on a subsequent flight will arrive in a shorter period of time than for small airports.

Difference between Expected and Perceived Waiting Times

EXPEDLAY, mentioned previously in this discussion, was found to influence the UPLOS at medium airports. The greater the value of EXPEDLAY, the better the UPLOS rating. The average value of EXPEDLAY for the medium airports was both negative and greater than at either the small or large airports, indicating that on average the perceived waiting time was greater than the expected waiting time, and that it exceeded it by a larger amount at the medium airports than at other airports. Thus, if either the waiting time is reduced or if a passenger's expectations can be lowered, the UPLOS can be increased.

Model Implementation

By evaluating the independent variables, these models can be used by any airport to evaluate and analyze the user-perceived BHS LOS. Either the aggregate model or the appropriate disaggregate model by annual passenger volume can be used. The independent variables can be separated into two distinct types: those that can be measured without user interference, and those that are perceived by the passengers. Those that can be measured directly are GENDER01 (percent of male respondents), RENO01CO, DISTGATE, GETBAG01 (percent of mishandled baggage), PXBGDLAY, SEATS# and BUSYPASS. Depending on the objective of the UPLOS evaluation, these values can be calculated by flight or as an average for the airport.

Those variables that should be evaluated by the respondents are CHEKBAGS, FLIGHTYR, TIMEARR, TIMEWAIT, and EXPEDLAY. However, these variables can be evaluated from studies conducted at an airport in the past and from relationships developed during this study. From previous surveys, the average number of checked bags per passenger (CHEKBAGS) and the average number of flights taken per year (FLIGHTYR) might be known at the airport of interest. In terms of its ability to predict UPLOS, TIMEARR is approximately the same as TIMEGATE (the author's measured walking time between the arrival gate and the reclaim area) and thus, the latter could be used instead.

The average perceived waiting time, TIMEWAIT, can be easily evaluated without asking the passengers directly. An individual can monitor passengers and keep records of their actual waiting time. Otherwise, the relationship between average perceived waiting time and annual passenger volume can be used to evaluate TIMEWAIT. This study indicated that average perceived waiting time, TIMEWAIT (minutes), is related to annual passenger volume, P (millions), with the following relationship.

$$TIMEWAIT = 3.5 + 1.02P$$

To evaluate EXPEDLAY, both the perceived waiting time (TIMEWAIT) and the expected waiting time must be known. The latter value can be controlled by the airlines by using electronic display boards and/or announcements (broadcast onboard the aircraft or within the terminal) to tell passengers what the expected waiting time for baggage is for each flight. Otherwise, a passenger survey can be conducted to evaluate the expected waiting time. The average UPLOS provided at an airport can be determined by evaluating the preceding variables, either by flight or for the airport as a whole.

Thus, these aggregate and disaggregate models can either be used to determine the prevailing UPLOS, or as a means of indicating to what degree the UPLOS is affected by each independent variable. This latter use provides airlines and airport authorities with a method for evaluating the effect of BHS modifications prior to their implementation and for analyzing BHS proposed for new terminals. Additionally, these independent variables provide a more comprehensive method of evaluating the LOS than the three traditional time and space variables.

CONCLUDING REMARKS

This paper presented a review of the current status of BHS at Canadian airport as a representative of its worldwide status. Based on this review the need to develop a national strategy for BHS was established. The research methodology was presented and selected data regarding the LOS as perceived by more than 800 passengers were analyzed. The factors affecting the LOS as perceived by the passengers were discussed and new user-perceived aggregate and disaggregate LOS models considering these variables were presented. Results from regression analysis indicated that waiting time and space in the reclaim area alone are not adequate indicators of the LOS perceived by passengers. Factors such as a passenger's *expected* waiting time, the perception of comfort and safety, and the walking distance between the arrival gate and the reclaim area influence the overall LOS evaluation. The need for more analysis is evident, as it will lead to the refinement of the LOS model. These user-perceived LOS models are important to airlines, airport authorities, and passengers in evaluating current and future needs of baggage handling facilities at airports. Airlines and airport authorities can apply the appropriate disaggregate model, or select the more general aggregate model, to evaluate the prevailing UPLOS. In addition, the models can provide airport managers with a tool for planning and designing airport improvements by understanding the effect of altering any of the independent variables. Finally, this paper was based on research work completed before the tragic events of September 11. Clearly, these events may require rearranging the priorities and weights of factors, which may or may not have been considered in this study. Obviously, security and origin and destination of the flight could alter the perception of passengers to LOS associated with baggage handling. A separate study can be initiated to assess these new factors.

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